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EARTH AND PLANETARY SCIENCE LETTERS

NOV 13 1974

A LETTER JOURNAL DEVOTED TO THE DEVELOPMENT IN TIME OF THE EARTH AND PLANETARY SYSTEM

Volume 5 No. 4, December 1968

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NORTH-HOLLAND PUBLISHING COMPANY - AMSTERDAM.

RELATIVELY PURE JADEITE FROM A SILICEOUS CORSICAN GNEISS

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Received 18 November 1968

The occurrence of a relatively pure jadeite (92–97% Jd) in equilibrium with quartz requires pressures at least as great as those required for the breakdown of albite. This contradicts the oft-repeated hypothesis that the apparently extreme pressures required to form quartz-jadeite are invariably reduced by impurities in the pyroxene. As most jadeites from metagraywackes are not in equilibrium with quartz and albite, pressures may often exceed that required for the albite → jadeite + quartz transition. The upper pressure limit of the glaucophane-lawsonite facies is not known.

Sodic pyroxenes have been described by Brouwer and Egeler [1] from the schistes lustrés belt of N.E. Corsica. More recently Autran [2] has found jadeite ($\text{Jd}_{92}\text{Ac}_4\text{Di} + \text{Hd}_4$, written communication, 1967) in gneisses a few km S.W. of Cerbione, Corsica. While engaged in a study of Corsican sodic pyroxenes the writer has found a relatively pure jadeite in a siliceous gneiss 0.2 km N of Campi. Microprobe analysis of this jadeite (table 1) shows that it is $\text{Jd}_{94}\text{Ac}_2\text{Ts}_1\text{Di}_0\text{Hd}_0\text{En}_2\text{Fs}_1$ *. Partial analyses of Na, Ca and Al (table 2) suggest that the pyroxene varies from 92 to 97% Jd. X-ray diffraction of the pyroxene reveals no sub-microscopic intergrowth of amphibole and the common quartz inclusions in the jadeite porphyroblasts are easily avoided during analysis due to their distinctive orange cathodo-luminescence. Some of the jadeites show secondary alteration to white mica and albite at grain boundaries.

Winkler [3], Coleman [4], Coleman and Clark [5] and others have pointed out that all analyzed jadeites of quartz-bearing rocks have >10% impurities, and have suggested that these impurities would significantly depress the equilibrium pressure below the albite = quartz-jadeite curve **. This conclusion is

* Part of the Ts is considered as Mg-Ts, $\text{MgAl}_2\text{SiO}_6$.

** It should be noted that experiments of Newton and Smith [7] have lowered this curve ≈ 1.8 kb below the older data at low temperatures.

Table 1
Microprobe analysis of jadeite Pg26

Oxide	wt. % ^a	molecular proportions	
SiO ₂	58.8	O	6.000
TiO ₂	0.13	Si	1.986
Al ₂ O ₃	24.4	Al IV	0.014
Cr ₂ O ₃	< 0.03	Al VI	0.953
⁶ Fe ₂ O ₃	1.46	Ti	0.003
MnO	< 0.03	Fe ⁺⁺⁺	0.020 ^b
MgO	0.96	Fe ⁺⁺	0.020 ^b
CaO	0.24	Mg	0.048
Na ₂ O	14.7	Ca	0.008
K ₂ O	< 0.03	Na	0.959
Σ	100.7	Σ cations	4.011

^a Standards used were Coleman jadeite for Na, Al, Si; Hess 39 for Ca, Mg, Fe (cf. Essene and Fyfe [6]). No corrections were made for Na, Al, Si; corrections following Smith [11] were made for Ca, Mg, Fe.

^b Total iron as Fe₂O₃. Using charge balance considerations the Fe⁺⁺/Fe⁺⁺⁺ ratio was estimated for the molecular calculation; this ratio gives wt % FeO = 0.72, Fe₂O₃ = 0.82.

untenable for the Corsican jadeite, as the few percent impurities will depress the equilibrium pressure only 0.1–0.2 kb (cf. Essene and Fyfe [6]; Newton and Smith [7]). Are their conclusions valid for the more

Table 2
Partial analyses of various points on the jadeite of PG26

wt %			Estimated ^a		
Na	Ca	Al	Jd	Ac	Other
11.0	0.11	13.2	96	3	1
10.9	0.22	12.9	94	4	2
10.9	0.19	12.9	94	4	2
11.1	0.14	12.9	94	2	4
10.7	0.32	12.8	93	6	1
10.9	0.17	12.9	94	4	2
11.0	0.17	12.9	94	3	3
10.8	0.19	12.6	92	3	5
11.1	0.11	13.1	95	3	2
10.8	0.22	12.8	93	2	5
10.8	0.17	13.0	95	0	5
10.9	0.17	12.9	94	2	4
11.2	0.08	13.3	97	1	2
11.1	0.18	12.8	93	0	7
11.1	0.26	12.6	92	1	7

^a Estimated assuming constant Ts, En, and Fs taken from total analysis. This allows conversion of Na, Ca and Al to molecular values/six oxygens. Then

$$\text{Na} = \text{Jd} + \text{Ac}$$

$$\text{Al} - 2\% (\text{Ts}) = \text{Jd}$$

$$\text{Other} = 100 - \text{Na}$$

impure jadeites? Newton and Smith [7] showed that 20% acmite depresses the stability of a jadeitic pyroxene in equilibrium with quartz and albite by only 0.6 kb at 600°, and they noted that their data on jadeite-acmite solid solutions are consistent with an ideal model. If one calculates the minimum stability of $\text{Jd}_{85}\text{Ac}_{15}$ at 300°C with an ideal model (cf. Essene and Fyfe [6]) using Newton and Smith's albite = quartz-jadeite curve and assuming that no Fe enters in the albite*, 0.7 kb stabilization is found. Kushiro's [8] experiments on diopside-jadeite, if applicable to the relatively low temperatures of the glaucophane-lawsonite facies, suggest that 15% diopside gives little

* The writer's analyses of albite in equilibrium with natural aegirine-jadeites reveal less than 1/3 of 1% $\text{NaFe}^{\text{III}}\text{Si}_3\text{O}_8$, and Newton and Smith's iron-rich albites synthesized from glasses are clearly metastable at low temperatures.

stabilization to jadeite †. Diopside and acmite are the major impurities, and the minor impurities Ts and Hd, being <3%, will not noticeably affect these stabilities. While natural impure jadeites could have crystallized at somewhat lower pressures than quartz-jadeite, this is only required if the pyroxenes equilibrated with albite. Without albite these jadeites could as well have crystallized at higher pressures and the impurities would have little petrogenetic significance.

Turner and Verhoogen [9], Winkler [3], Essene and Fyfe [6] and others noted that a few jadeitic pyroxenes appear to have equilibrated with albite and quartz, and the albite = quartz-jadeite curve provides an upper pressure limit for rocks with this assemblage. Coleman and Clark [5] further believe that the albite segregations and veins so common in the metagreywackes validate this conclusion for all the jadeite metagreywackes. It is worth noting that the albite segregations and veins may replace the groundmass jadeite (Essene [10]), and this late albite does not appear to have equilibrated with the groundmass jadeite. The large areas of jadeite metagreywackes lacking primary albite may well have been subjected to pressures in excess of that necessary to decompose albite; the Corsican jadeite certainly reached these pressures. Contrary to the conclusion of Coleman and Clark [5], the albite = quartz-jadeite curve cannot as yet be regarded as the upper pressure limit of the glaucophane-lawsonite ("blueschist") facies.

ACKNOWLEDGEMENTS

The conclusions of this short note have certainly been aided by discussions with Profs. W.S.Fyfe and F.J.Turner. The writer also wishes to thank Dr. D.H. Green, N.L.Gray and P.Jakes for reading the manuscript. The research in Corsica was aided by an N.S.F. Postdoctorate Fellowship.

† This disagrees with tentative conclusions drawn from a somewhat unrealistic ideal solution model for diopside-jadeites by Essene and Fyfe [6].

REFERENCES

- [1] H.A.Brouwer and C.G.Egeler, The glaucophane schist facies metamorphism in the schistes lustrés nappes of Corsica, Proc. Kon. Ned. Akad. Wetensch. tw. rks. 58 (1952) 3.
- [2] M.A.Aufran, Description de l'association jadeite + quartz et des paragéneses minérales associées, dans les schistes lustrés de Sant Andrea di Cotone (Corse), Bull. Soc. Franc. Min. Crist. 87 (1964) XLIII-XLIV.
- [3] H.G.F.Winkler, Petrogenesis of Metamorphic Rocks (Springer-Verlag, New York, 1965) pp. 142, 151.
- [4] R.G.Coleman, Composition of jadeitic pyroxene from the California metagreywackes, U.S. Geol. Surv. Prof. Paper 525.C (1965) C25-C34.
- [5] R.G.Coleman and Joan R.Clark, Pyroxenes in the blueschist facies of California, Am. J. Sci. 266 (1968) 43.
- [6] E.J.Essene and W.S.Fyfe, Omphacite in Californian metamorphic rocks, Contr. Mineral. Petrol. 15 (1967) 1.
- [7] R.C.Newton and J.V.Smith, Investigations concerning the breakdown of albite at depth in the earth, J. Geol. 75 (1967) 268.
- [8] I.Kushiro, Clinopyroxene solid solutions at high pressures, in: Ann. Rept. Director, Geophys. Lab. for 1964-1965, Carnegie Inst. Wash. Yearbook 64 (1965) 112.
- [9] F.J.Turner and J.Verhoogen, Igneous and Metamorphic Petrology, 2nd ed. (McGraw-Hill, New York, 1960) 544.
- [10] E.J.Essene, An occurrence of cymrite in the Franciscan formation, California, Am. Mineral. 52 (1967) 1885.

